Gravatt, Dan

From:	Dan Feezor <dfeezor@feezorengineering.com>
Sent:	Friday, November 15, 2013 5:28 PM
To:	Tapia, Cecilia; Asher, Audrey; Gravatt, Dan; Jessica E. Merrigan
Cc:	Brian Power; Craig Almanza; Beck, Bill (LG); Cunningham, Ally (LG); Paul Rosasco; mike bollenbacher; Jessica E. Merrigan; Aaron Karlas; Paul Eastvold; Dan Feezor; Peter Carey
Subject:	Re: Amended GCPT Work Plan and Cover Letter
Attachments:	11-15-13 Cover Letter to USEPA- Phase 2 Work Plan - Final.pdf; Phase 2 Work Plan.pdf

Ms. Tapia,

As per our discussions with Mr. Dan Gravatt attached is the Bridgeton Landfill Phase 2 Work Plan which discusses the core samples for the Area 1 investigation after the GCPT investigation is completed. We will be proposing precise locations once we have concluded the Phase 1 - GCPT work. Therefore, we will be submitting a revision at a later date.

If you have any questions, please contact me.

Thank you,
Dan Feezor

Feezor Engineering, Inc.
(217) 836-8842

0714 40487027 3.0

Superfund

BU-01

Engineering for a Better World
FEEZOR
ENGINEERING, INC.

November 15, 2013

Ms. Cecilia Tapia
Director
Superfund Division
United States Environmental Protection Agency
Region 7
11201 Renner Boulevard
Lenexa, Kansas 66219

RE: Bridgeton Landfill / OU-1 Coring (Phase 2 Investigation)

Dear Ms. Tapia:

On behalf of our client, Bridgeton Landfill, LLC (hereinafter Bridgeton Landfill), Feezor Engineering, Inc. (FEI) hereby submits the *Core Sampling (Phase 2) Work Plan.* This is consistent with Environmental Protection Agency's (EPA) September 20, 2013, letter directing the investigation under the Additional Work provision of the Administrative Order on Consent for the West Lake OU-1 Superfund Site.

At the time this work plan is being authored, the Phase 1 Gamma Cone Penetration Test (GCPT) investigation is ongoing. As discussed with Dan Gravatt, final details of the Phase 2 Investigation will need to be determined following completion of the GCPT investigation. This Work Plan is being provided now in the interest of accelerating the overall review time and minimizing downtime between the Phase 1 and Phase 2 investigations.

This work plan was prepared under the direction of a Missouri Professional Engineer (Daniel Feezor, P.E., MO P.E. Number E-30292).

Thank you again for your cooperation in this matter. We look forward to working with you. If you have any questions, please feel free to contact me at (217) 483-3118 or Bridgeton Landfill's Environmental Manager Brian Power at (314) 744-8165.

Sincerely,

Daniel R. Feezor, P.E.
Feezor Engineering, Inc.
dfeezor@feezorengineering.com

Attachment: Core Sampling (Phase 2) Work

ENGINEERING FOR A BETTER WORLD
FEEZOR
ENGINEERING, INC.

BRIDGETON LANDFILL—WEST LAKE LANDFILL

CORE SAMPLING (PHASE 2)
WORK PLAN

BRIDGETON, ST. LOUIS COUNTY, MISSOURI

STATE OF MISSOURI
DANIEL
RICHARD FEEZOR
NUMBER
E-30292
REGISTERED PROFESSIONAL ENGINEER

11/15/13

Prepared For:
Bridgeton Landfill, LLC
13570 St. Charles Rock Road
Bridgeton, MO 63044

November 15, 2013

Project No.: BT-012

Prepared By:

Feezor Engineering., Inc.
406 East Walnut Street
Chatham, IL 62692
Missouri Professional Engineer
Number 030292

P. J. Carey & Associates
5878 Valine Way
Sugar Hill, GA 30518

In conjunction with:

Engineering Management Support, Inc.
722 West Jefferson Ave, Suite 406
Lakewood, CO 80235

Auxier and Associates, Inc.
9821 Cogdill Road, Suite 1
Knoxville, TN 37932

Core Sampling Work Plan (Phase 2)

Bridgeton Landfill, LLC

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

A detailed subsurface investigation is being performed in Area 1 of Operable Unit 1 of the West Lake Landfill Superfund Site in order to identify the optimum location and obtain geotechnical data for an isolation /thermal barrier immediately to the north of the Bridgeton Landfill - North Quarry Area. This is consistent with Environmental Protection Agency's (EPA) September 20, 2013, letter directing the investigation under the Additional Work provision of the Administrative Order on Consent for the West Lake OU-1 Superfund Site.

At the time this work plan is being authored, the Phase 1 Gamma Cone Penetration Test (GCPT) investigation is occurring to ascertain the optimum alignment for the isolation / thermal barrier. While final details of the Phase 2 Investigation will need to be determined following completion of the GCPT investigation, this Work Plan is being provided in the interest of accelerating the overall review time and minimizing downtime between the Phase 1 and Phase 2 investigations.

Prior investigations (EMSI, 2000 and McLaren/Hart 1996) provided data that were used to define the extent of Radiologically-Impacted Material (RIM) in Area 1. Review of these data indicates that RIM does not extend to the area where the isolation/thermal barrier is anticipated to be located. The Phase I GCPT investigation is being performed to further verify the conclusion that RIM is not present in the area being considered for the location of the isolation/thermal barrier. In addition, the GCPT investigation is being performed to ascertain geotechnical information for the barrier design such as the subsurface liquid levels and the bottom elevation of waste.

This document prescribes the location, technology, and methodology in order to define the proposed barrier alignment, south of Area 1 that is suitable for the installation of the Phase 2 investigation.an isolation/thermal barrier designed to isolate the RIM from the Bridgeton Landfill's waste mass. The objective of Phase 2 of this project is to collect and analyze soil core samples for the presence or absence of RIM as well as to confirm the characteristics of the subsurface material along the proposed barrier alignment determined from the QCPT at a limited number of locations. The Phase 2 investigation will also be used as a verification of the GCPT methodology and interpretations for the geotechnical data.

1.1 PROJECT HISTORY

1.1.1 Site Conditions

In the 1970's West Lake Landfill received contaminated waste, including soil mixed with leached barium sulfate residues containing traces of uranium, thorium and their long-lived daughter products. The presence of the RIM resulted in the West Lake Landfill being designated as a Superfund site. For purposes of this Work Plan, RIM will refer to radiologically impacted material present at a level above that deemed appropriate for unrestricted use (5 pCi/g above background). The RIM is located in two areas at the site: Area 1, which is adjacent to the North Quarry Landfill and thus is pertinent to this investigation; and Area 2, which is located along the northern portion of the site. Area 2 is approximately 1,000 feet (at the closest) from the outer boundary of the North Quarry Area and is separated from it by a road and a closed demolition landfill (Figure 1). Collectively, these two areas have been designated as Operable Unit 1 for the Superfund investigation and remediation activities while the rest of the site was designated as Operable Unit 2.

The southern border of Area 1 is contiguous to the waste mass of Bridgeton Landfill, a quarry-fill landfill containing municipal waste. At the present time, Bridgeton Landfill is experiencing a Subsurface Smoldering Event (SSE) in its South Quarry Area. While the SSE is currently a significant distance from OU-1 Area 1, Bridgeton Landfill wishes to develop a response strategy to ensure that the SSE does not spread into the Area 1 RIM. Bridgeton Landfill, LLC has committed to constructing a subsurface thermal / isolation barrier located between Bridgeton Landfill's waste mass and the RIM located within West Lake OU-1 Area 1. As directed by EPA, this work will be conducted pursuant to an Administrative Consent Agreement and Order on Consent with EPA.

1.1.2 Proposed Thermal / Isolation Barrier

Bridgeton Landfill has evaluated the possibility of an excavated isolation barrier as a contingency means to prevent the SSE from advancing into the radiologically impacted material in West Lake OU-1 Area 1. Specifically, Bridgeton Landfill evaluated the excavation of waste to create an isolation barrier south of the southern limit of radiologically impacted material. Such an approach would also limit the volume of waste excavation, consistent with concerns raised by the Lambert-St. Louis International Airport Authority. Finally the relative speed of construction, about three months, allows such a system to be implemented quickly.

Conceptual evaluation of barrier designs, reported in the March 29, 2013, letter to Mrs. Fitch of the Missouri Department of Natural Resources (MDNR) from Craig Almanza, identified potential alignments along which the thermal / isolation barrier could be constructed. The conceptual evaluation also identified that the amount of material requiring excavation and the depth of such a barrier would be substantially lessened – along with all the negative impacts associated with waste excavation – if the thermal / isolation barrier alignment were moved toward the north. This would allow avoiding the existing slopes of the North Quarry fill and would reduce the depth of excavation along the eastern portion of the alignment, where quarry activity followed by landfilling would require a much deeper excavation the farther south the thermal / isolation barrier is located.

It is envisioned that the thermal / isolation barrier will be excavated in the non-RIM portions of Area 1, and the purpose of the Phase 1 and Phase 2 Investigations is to identify such a location. Detailed construction plans for the Isolation Barrier will be submitted for EPA review following conclusion of the investigation work directed by EPA's September 20, 2013 letter.

In order to develop the design plans for the thermal / isolation barrier, additional subsurface data is needed between known extent of the RIM within West Lake OU-1 Area 1 and the Bridgeton

Landfill - North Quarry Area. Phase 1 of the project used Cone Penetration Tests (CPTs) to determine the characteristics of the subsurface materials within proposed alignments of the thermal / isolation barrier and the southern edge of the Area 1 fence. The CPT device was also capable of measuring gamma counts which can increase the likelihood that the proposed isolation barrier can be constructed without encountering RIM. Regardless of the investigation results, radiological scanning will occur during the barrier excavation to ensure RIM is not being relocated.

Consistent with EPA direction, this Gamma Cone Penetration Test (GCPT) investigation is the first of two phased investigations to confirm the thermal / isolation barrier location. This Work Plan (Phase 2) along with a corresponding Health and Safety Plan for a boring / coring technology, is being submitted to detail the locations and procedures of borings, core sample collection, and sampling for radioisotopes within the proposed thermal / isolation barrier alignment. Phase 1 of the investigation allows for the collection of information south of and, in some locations, up to the projected extent of RIM material occurrences, in order to confirm the absence of RIM in the location selected for the potential thermal / isolation barrier alignment.

1.2 Goals of the Investigation

The goals of the investigation are to gather the required geotechnical data for design and to provide confirmatory observations that material within the proposed excavation area for the potential thermal / isolation barrier alignment does not contain radiologically impacted material above the level appropriate for unrestricted use. The approximate limits of the materials containing materials higher than the standard for unrestricted use (5 pCi/g above background) were delineated in the 2011 Supplemental Feasibility Study.

The primary goals of the GCPT investigation (Phase 1) were to:

- Determine the stratigraphy, nature, and geotechnical properties of subsurface materials for design purposes,
- Determine liquid levels,
- Determine if any RIM exists within the potential barrier excavation footprint,
- Determine depth to native material, and
- Use the above information to select the best alignment for the barrier (proposed alignment).

The primary goal of the Core Sampling investigation (Phase 2) will be to quantify subsurface concentrations of isotopic elements within the thermal / isolation barrier construction area. This will involve:

- Installation of a sufficient number of boreholes to verify the GCPT data within the thermal /isolation barrier excavation limits~~,~~
- Produce geophysical and radiometric logging data from each soil core,
- Collect samples of soil materials from each length of the borehole (minimum 2 per borehole),
- Generate down hole gamma logs that will be used to prioritize sample analysis from the borehole samples collected,
- Submit soil samples to a certified, independent laboratory for radioanalyses and
- Determine type of waste/subsurface material (i.e. rock, municipal solid waste, construction and demolition waste, etc.)

The design process will use the results of the Phase 1 GCPT investigation to conceptually design the thermal / isolation barrier. Data such as depth of waste, liquid levels, width of thermal / isolation barrier, allowable slopes, and staging requirements will be used in the alignment and "daylight" line projections, which will guide the coring location selection.

To minimize delay between the Phase 1 and Phase 2 investigations, the EPA has requested an expedited development of the Phase 2 Work Plan. At the time this work plan is being authored, the Phase 1 GCPT work is still being performed. Therefore, this Phase 2 work plan will discuss the procedures and protocols that will be followed for the Phase 2 Core Sampling, but actual locations of the core samples and boring locations are unknown at this time. An amendment to the Phase 2 work plan will be submitted once the locations have been selected.

2 PREVIOUS INVESTIGATIONS

Previous investigations in the vicinity of the thermal / isolation barrier did not contemplate construction of a physical structure; therefore, high-density geotechnical data does not exist. However, previous investigations have evaluated presence of radiologically impacted materials at West Lake Landfill using downhole gamma radiation logging of soil borings, collection and analyses of surface and subsurface soil samples, and overland gamma surveys.

2.1 PRIOR INVESTIGATION METHODS

Downhole gamma radiation logging and overland gamma surveys were used as the primary detection methods for these investigations. In addition, soil samples were collected for analyses of uranium, radium, thorium isotopes and their decay products as well as for non-radiological constituents. Results of these investigations are presented in the Soil Boring/Surface Sample Investigation Report (McLaren/Hart, 1996) and the OU-1 Remedial Investigation Report (EMSI, 2000). Eight radionuclides were identified as contaminants of concern based on their long half-lives: U238, U234, Th230, Ra226 and Pb210 from the U238 series; U235 and Pa231 from the U235 series, as well as Th232. Isotopes from the Thorium-232 decay series are also present at levels above background, although to a lesser extent.

2.2 RESULTS OF PREVIOUS INVESTIGATIONS

2.2.1 Extent of Area 1 Contamination

Downhole gamma logging by McLaren/Hart in Area 1 found elevated radiation levels varying from zero to sixteen feet below ground surface (bgs), while the thickness of the materials generally ranged from one to five feet in Area 1. In the northwest region of Area 1, elevated readings ranged from zero to six feet bgs, while to the southeast, elevated readings were found as deep as 15 feet bgs. The impacted area is illustrated in Figure 2.

An overland gamma survey McLaren/Hart (1996a), Overland Gamma Survey Report, West Lake Landfill, Radiological Areas 1 & 2, Bridgeton, Missouri, April 30, also detected gamma radiation above background at the ground surface. Results of the overland gamma survey are also shown in Figure 2. Laboratory analyses of surface soil samples (the upper 6 inches) detected radionuclides at levels above 5 pCi/g above background at boring locations WL-106 and WL-114.

The 2011 Supplemental Feasibility Study (SFS) included a detailed estimate of the extent of RIM. An outline of the known impacted material was created using the available boring data, as well as an outline of the known non-impacted area (see SFS Appendix B-2, Figures 3 and 4). Based on these boundary conditions, the estimated border of the RIM was interpolated between these two boundaries. These boundaries, the interpolated RIM limits, and borings used to estimate the limits are shown in Figure 2 of this Work Plan.

The SFS delineation of the extent of RIM was sufficient for purposes of developing and evaluating potential remedial alternatives for OU-1. However, construction of the thermal / isolation barrier requires a high degree of confidence that the alignment for thermal / isolation barrier is located outside of the extent of RIM. Therefore, as part of geotechnical investigation of the proposed alignment, data is also being obtained to confirm that the selected alignment is outside the location of RIM above levels for unrestricted use.

3 ONGOING INVESTIGATION

3.1 GCPT INVESTIGATION (PHASE 1)

The Phase 1 GCPT Investigation was detailed in the September 27, 2013 document entitled "Bridgeton Landfill – West Lake Landfill Gamma Cone Penetration Test (GCPT) Work Plan Revision 2" prepared by Feezor Engineering, Inc., P.J. Carey and Associates, Engineering Management Support, Inc., and Auxier and Associates, Inc. This work plan described the procedures and protocols to advance a piezocone sounding in an array between the known RIM area in Area 1 of OU-1, and the southern edge of OU-1 Area 1. Each piezocone sounding collects data regarding the stratigraphy, nature, and geotechnical properties of the materials as well as liquid levels, as relates to the design of the thermal / isolation barrier system. In the same CPT sounding, gamma radiation logging was performed using a proprietary device that is included in the equipment tool string behind the GCPT head. The device used a Cesium Iodide crystal. The device differs from a typical downhole logging gamma detector in that it is part of the push rod system and therefore has greater shielding from the thicker rod walls and is smaller in diameter for the same reason. However the device has been used successfully on other projects to detect the differences between clays and silts.

Tip force, sleeve force and pressure are all recorded as the push rods are advanced. Reading intervals are taken at intervals not exceeding 50 mm. The advance rate of the probe is approximately 2 cm/second, which is the ASTM Standard.

The type of soils, including waste materials, was inferred based on the analysis of combination of tip, sleeve and pore pressure while advancing (referred to as dynamic pore pressure). Work at other sites has demonstrated that interfaces between waste material and natural soil can be identified.

The technique described in the approved workplan involved an overland gamma scan, then clearing the brush / vegetation to deploy a geotextile and stone to provide all-weather roadways for investigative equipment. Once the clearing and road development was completed, the GCPT equipment could proceed, and findings developed. All equipment and personnel followed the radiological screening and safety protocols as discussed with the Phase 1 work plan and complementary Health and Safety Plan (HASP).

4 PROPOSED INVESTIGATION

4.1 OVERVIEW OF TECHNIQUE

As stated previously, the purpose of the GCPT investigation is to verify the absence of RIM in the area where excavation would be performed to construct an isolation/thermal barrier. The GCPT investigation will provide qualitative data regarding the presence and nature of the materials encountered and was not intended to be quantitative. After review of the initial data obtained from the GCPT investigation (Phase 1), the proposed location for the thermal / isolation barrier will be will be determined. Select locations within the area of potential excavation for construction of an isolation/thermal barrier will then be core drilled to a depth 10 feet below the waste materials. Samples will be collected for analytical testing for radiological isotopes and geotechnical property characterization. This drilling, coring, and testing protocol will be known as the Phase 2 investigation.

The soil core samples will be collected using sonic drilling, GeoProbe drilling, or other available and appropriate technologies. Samples for radiochemistry analyses will be collected using Auxier Procedure 3.3. The soil samples will be taken at various depth locations of the core boring sample subject to where soil materials are encountered in each boring. Biased samples will be taken at locations of radioactivity as identified by field radiation detection instruments. Other samples will also be taken where no radiation is detected by such radiation detection instruments.

4.2 LOCATION OF BOREHOLES

As previously discussed within this workplan, the proposed location of the proposed thermal / isolation barrier is unknown, and will remain unknown until the Phase 1 GCPT investigation is completed. After the Phase 1 investigation has concluded a conceptual design of the thermal / isolation barrier can provide guidance to the location of the Phase 2 boring locations. The desired locations of the proposed boreholes will be distributed at regular intervals along proposed corridor.

4.3 BORING TECHNIQUE

4.3.1 Sonic Drilling

The Missouri Department of Natural Resources (MDNR) suggested a coring procedure such as a sonic drilling within their August 20, 2013 letter to the Bridgeton Landfill, LLC. Therefore, the sonic drilling technique will be used to advance the borings and collect core samples. Other drilling methods may be considered.

The sonic drilling technique in accordance with ASTM D6914 will be used for the advancement of a continuous core for each borehole. ASTM D6914 provides guidance and discussion about this technique which is summarized in this section.

Sonic drilling is used for geoenvironmental investigative programs. Sonic drilling offers the benefit of significantly reduced drill cuttings and reduced fluid production. The continuous core sample recovered provides a representative lithological column for review and analysis. The ability to cause vibration to the casing string eliminates the complication of backfill bridging common to other drilling methods and reduces the risk of casing lockup allowing for easy casing withdrawal during grouting.

The cutting action, as the sonic drilling bit passes through the formation, may cause disturbance to the soil structure along the borehole wall. The vibratory action of directing the sample into the sample barrel and then vibrating it back out can cause distortion of the specimen. Core samples will be hydraulically extracted from the sample barrel to reduce distortion. The use of split barrels, with or without liners, may improve the sample condition but may not completely remove the vibratory effect.

It is envisioned that some GCPT soundings will be impossible due to large concrete construction and demolition debris. The sonic rig will be able to penetrate these formations. Sonic drilling through construction and demolition debris material may require the use of fluid (no air drilling allowed) to remove drill cuttings from the face of the bit, as they generally cannot be forced into the formation.

Some heat generation may occur within the borehole due to the use of sonic drilling. Liquid (potable water) will be injected down the drill string to reduce potential heat generation. Use of liquid will also increase core recovery. No liquid return to the top of the boring is anticipated.

4.3.2 Other Techniques

While it is not envisioned to be used for the Phase 2 investigation, a geoprobe may be attempted in areas without overlying construction and demolition debris. If this technique can be used successfully, then both sonic drilling and geoprobe techniques may be used.

4.4 Boring Locations

The specific number and locations of borings will be determined based on the results of the Phase 1 GCPT investigation.

4.5 Site Preparations

The selected location for a given soil boring will be located and marked by a land surveyor before sampling will begin at that location. These locations will be surveyed, horizontally and vertically, using the local Site coordinate system and recorded.

4.6 Equipment Preparation and Safety Training

Equipment will be in proper working order and inspected to determine if they meet safety requirements per A&A Procedure 2.1(2) in **Appendix A**. Personnel will be briefed on potential hazards including working around moving equipment, physical hazards, biota, and risks associated with radiological or chemical exposures. Health and Safety Protocol/Procedures pertaining to general and radiological aspects of drilling in impacted areas are included in the Phase 2 Health and Safety Plan (HASP) which will be submitted at a later date.

It is anticipated that all work will be completed in modified OSHA level D personal protective equipment (PPE), as required by the A&A Radiation Safety Officer (RSO). A proposed alignment for the isolation/thermal barrier located outside of the area containing RIM will be identified based on the results of the prior investigations and the results obtained from the Phase I GCPT investigation. Therefore, respirators for protection from radionuclide exposure will not be routinely required. Respirators for protection from dust inhalation may be used if there are continuous plumes of visible dust from the borehole or soil cores; however this condition is not anticipated to occur.

Survey instrumentation will be calibrated and documentation of calibration will be available for inspection. Sampling equipment and industrial hygiene monitoring equipment will be in proper working order and documentation of calibration (if applicable) will be available for inspection. A daily instrument response check will be performed on all radiological instruments used for quantitative measurements before the instruments are used. The results of these response checks will be recorded and retained for inspection.

Personnel will comply with the site-specific HASP and with the site-specific Radiation Safety Plan on file in the Site field office. A&A will provide appropriate, site-specific radiation training to workers involved with this sampling effort.

4.7 Borehole Sampling

The investigation activities will be conducted using sampling technology associated with the sonic drilling technique (ASTM D6914) or a geoprobe such as a GeoprobeTM-type rig equipped with a 3" Geoprobe Dual Tube sampling system with acetate liners (or equivalent). The Sonic drilling /Geoprobe crew will proceed to each marked borehole location and continuous soil cores will be collected and logged. If the planned location cannot be safely reached, the hole will be skipped, pending further direction from the Project Manager.

At each boring location, soil cores will be advanced through any overburden and into the underlying landfill deposits, terminating in the underlying unconsolidated material. If refusal is met, the borehole location may be off-set at the discretion of the Project Manager. It is anticipated that the total depth of each boreholes will be approximately 30 to 60 feet below ground surface (bgs) but may extend as far as 80 feet in places. Soil cores from these boreholes will be labeled with a unique sample identification number that will include a reference to the boring designation from the sampling map, the borehole number (if more than one borehole is taken at the same location), the core sequence number or depth interval, an arrow indicating the top of the soil core, and the date.

Soil cores obtained from each borehole will be examined by the accompanying geologist//field engineer. At a minimum, the geologist/field engineer will identify the depths that soil transitions from one subsurface unit to the next and identify any stratum that may affect the installation or efficacy of the thermal / isolation barrier. The entire soil core from the borehole will be stored in sealed PVC pipes.

4.8 Subsurface Measurements

Vertical scanning of the borehole (borehole gamma logging) and gamma scanning of the produced soil core will be used to initially verify the absence of RIM, or if field screening indicates a potential for RIM to be present identify the in-situ depth and thickness of soil deposits that produce an anomalous radiation reading. This information will provide accurate depth information if an anomalous radiometric result is encountered.

Soil core gamma logging will locate any soils in the sample tube that may produce elevated levels of gamma radiation. This allows samplers to match potentially impacted soils to their correct depths (indicated by the downhole gamma logs) even if the soil column is displaced to a different depth in the tube during sampling.

4.8.1 Borehole Gamma Logging

Once the borehole has reached its total depth, a waterproof, PVC sleeve will be inserted into the hole. A 1-inch NaI probe with a long cable will be used to record one (1) minute radiation measurements at half foot (6-inch) intervals along the length of each borehole. These measurements will be recorded in counts per minute (cpm) and the depth of each measurement will be recorded as depth bgs in negative feet. For example, the depth of a gamma measurement taken at 3.5 feet bgs will be recorded as "-3.5 feet". This "gamma log" will be used to identify the depth bgs of the subsurface soil layers producing elevated radioactivity. **Appendix B** contains a modified borehole logging procedure excerpted from the Auxier & Associates procedure manual.

4.8.2 Soil Core Gamma Scanning

Concurrently with borehole logging, radioactivity from the soil core will be determined by taking 1-minute integrated gamma measurements at 1-foot intervals using a 3x3 inch NaI detector along the length of the core(s) that holds the upper strata of fill and refuse material. Once all measurements have been taken along the tube, they will be averaged, and the highest single value will be compared to the calculated average. If the maximum value exceeds the average by 30% or more, the associated 1-foot interval of soil will be identified in the field notes for that tube and the sample associated with that interval will be selected for expedited analysis.1

[1] This 30% criterion, called the Elevated Measurement Location (EML) criterion, is adapted from FSPM 12.7.10.

4.8.3 Geological Examination of Soil Core

A geologist/field engineer will review the core samples and log the boring based upon the cores and the corresponding depths. A geologic log for each boring will be developed.

4.9 Soil Sampling

Soil samples will be collected based upon the results of the soil core gamma scanning. Intervals with elevated gamma readings (if any) will be sampled. In addition, 2 randomly spaced samples will be collected from each boring. The depth of the sample will be determined by measuring from the ground surface. In general, a 500 to 700 gram (g) soil sample will be sufficient. The combination of geophysical information, the down-hole log and the sample tube activity will be used to identify any samples that may require expedited analysis.

The PVC sleeve will be extracted from the hole after gamma logging is complete, and remaining material from the soil core will be placed back down the open borehole. The hole will be grouted once the excess core material has been returned to the hole.

4.10 Sample Handling and Shipping

Each sample will be placed in a zip-lock bag and the bag will be completely sealed. The outside of the bag will be marked with a unique identification number and dated.

To be consistent with the system used in previous sampling campaigns, unique sample identifiers will consist of an alpha-numeric code including the area label, the borehole identifier, the sample type and matrix, followed by the sample depth. The numeric portion of the sample identifier describing the depth will be separated from the borehole information by a dash "-". The starting and ending depths will be separated by a dash. The identifiers expected for this sampling campaign are listed below:

- Area label: Area 1 (A1)
- Borehole ID: A three digit descriptor of the borehole location, such as 12-3 for the third borehole along corridor 12 or equivalent. Note the 2-digit number designating numerical order along the corridor (01, 02, ... 10, etc.). This is desirable when sorting results for presentation.
- Sample Type and Matrix: IS (investigation soil)
- Sample Depth: This will consist of start and stop sample depths in centimeters with a dash between the two depths, such as 000-006 (0-6 inches). Note – grab samples of soil will have only one depth value associated with them (000-000).

For example, a soil sample collected in Area 1 (A1) from the third borehole along Path 4 (P04) for investigative purposes (IS) across a depth interval of 12 to 15 in would be labeled:

A1P04IS 012-015.

The bags will be stored in a secure location in a manner that maintains chain-of-custody requirements until such time as they are ready for shipment. If samples are selected for laboratory analysis, they will be double bagged, logged on a chain of custody form, and placed in a cooler or a similar strong-tight container. The chain of custody form for that shipment will be placed in the cooler until the cooler is shipped. Prior to sealing the cooler, the cooler will be surveyed with a Model 19 or equivalent and the maximum reading will be recorded on the chain of custody form. The original chain of custody will be placed in the cooler and a copy retained at the Site. The cooler will be completely and securely sealed prior to shipment. (See A&A Procedure 3.8(1) "Sample Chain of Custody") see **Appendix C.**

4.11 Sample Processing

All core samples will be sent to Eberline Services Oak Ridge, Tennessee, for analyses of radionuclides. All samples will be packaged and shipped to the laboratory in accordance with USDOT regulations. Results of the sample analyses are not expected to be received for four weeks from the time the samples are received by Eberline Laboratories.

Upon receipt, the coolers will be opened and the samples checked against the chain-of-custody form. All samples will be weighed prior to drying. After samples are dry, the samples will be reweighed and then ground to promote homogeneity.

4.12 Sample Analysis

As discussed above, samples collected during this sampling campaign will be shipped to Eberline Services in Oak Ridge for processing and analysis.

4.12.1 Alpha Spectroscopy

Isotopic thorium and isotopic uranium will be determine using alpha spectroscopy at Eberline Services at Oak Ridge, TN.

4.12.2 Gamma Spectroscopy

Gamma spectroscopy analysis of the soil samples will be conducted at Eberline Services in Oak Ridge, TN. The target analytes will be radium isotopes, Bi-214, Pb-214 and Pa231; but a full report on all gamma emitters will be requested.

4.12.3 Analytical Methods

Analyses will be performed using approved analytical techniques by qualified individuals using industry standard methods such as EML U-02 (isotopic uranium), EML Th-01(isotopic thorium) and LANL ER-130 (gamma spectroscopy). The laboratory must also successfully participate in annual performance testing such as that conducted by Environmental Resource Agency or the Department of Energy (i.e. the Mixed Analyte Performance Evaluation Program or MAPEP). A summary of auditable aspects of the sampling QA/QC approach is provided in Table 1.

4.13 Surface Radiation Measurements

Exposure and dose rates will be measured over each borehole location before boring starts. In addition, thermoluminesent dosimeters (TLD)s or equivalent will be installed at 1-meter above a minimum of three (3) marked boreholes. These will be collected after 10 weeks or before wall installation, whichever is sooner, and sent to the vendor for processing. These measurements will be used document exposure rates within Area 1.

Table 1 -Analytical Methods/Quality Assurance Table

Parameter	Value
Matrix type	Soil
Number of samples to be collected	TBD
Number of samples to be analyzed	TBD
Number of field, equipment and trip blanks	TBD
Analyte (Radionuclide of Interest)	Isotopic uranium, and thorium, and radium
Analytical methods	100% Alpha spec for isotopic uranium and thorium 100% Gamma spec with 21-day ingrowth period for radium isotopes and other unspecified gamma emitters.
Number and type of matrix spikes (MS)	According to approved laboratory SOPs
Number and type of duplicate samples	5% for soil
Number and type of split samples	Number and type not currently known. Samples may be split as requested by other parties.
Number and type of performance evaluation samples	According to approved laboratory SOPs
Sample preservation	TBD and applicable to water samples only
Sample container volume and type	Soil: 1-gallon Ziploc bag, or equivalent
Sample holding time	None for radioanalytes

4.14 Project Team

This Plan was prepared by Auxier & Associates, Inc. (A&A), a wholly owned subsidiary of USA Environment, LP (USA) and Feezor Engineering, Inc. (Feezor) at the request of Bridgeton Landfill, LLC.

4.14.1 Bridgeton Landfill, LLC

Bridgeton Landfill, LLC will retain overall management for the project and will retain Feezor Engineering, Inc. Auxier & Associates and other necessary subcontractors to provide services necessary to characterize subsurface conditions along the proposed corridors.

4.14.2 Feezor Engineering, Inc.

Feezor Engineering, Inc. (FEI) is the Project Manager selected to manage the investigation and coordinate required operations on and off the site. FEI will supply GPS coordinates for the selected sampling locations. FEI will verify that all geospatial data is correct and fully documented. FEI will determine that:

- actual sample locations correspond to specified coordinates;
- elevation and depth bgs data is available for all actual sample locations, and
- coordinates, elevations and depths of any relocated sample locations are captured and documented.

FEI will supply a geologist/field engineer to accompany the field team and examine the soil cores. The geologist will receive the cores from the driller, label them, and prepare geologic/engineering descriptions of the soil cores as they are produced by the drillers. FEI will provide maps and drawings using data collected. FEI will also develop the final report summarizing the findings in the Phase 2 investigation.

4.14.3 Auxier & Associates, Inc.

A&A personnel have responsibility for collecting, packaging, and shipping samples and for all radiological measurements described in this plan. A&A will collate and manage the radiological data produced, validate and analyze the data produced by this sampling campaign and prepare and submit a report summarizing the results.

A&A will supply the Site Survey Manager, to be determined, who will manage and perform the radiological measurements and sampling described in this work plan and the HASP. Mr. Mike Bollenbacher, CHP will provide technical oversight on the radiological aspects of the field sampling and analytical activities.

4.14.4 Drilling Subcontractor

A drilling subcontractor will be selected. The drilling contractor will sample soil by installing 3-inch diameter boreholes at surveyed and marked locations. The drilling contractor will insert 2-inch I.D. plastic sleeves in the borehole after cores have been extracted and will remove the 2-inch I.D. plastic sleeves from the borehole after they have been logged. They will supply all materials necessary to collect soil cores from those boreholes including direct push equipment capable of advancing boreholes to a depth of up to 100 feet, acetate liners and end caps, borehole inserts and any necessary support vehicles and portable work tables.

4.14.5 Surveying Contractor

A land surveying company will be selected to complete the land survey work prior to task completion.

5 CONTAMINATION SURVEYS AND DECONTAMINATION PROCEDURES

The potential to spread contamination will be mitigated by checking equipment and personnel as they leave Permitted Areas. If contamination is identified, the contamination will be removed and the equipment rechecked. This is an iterative process that will continue until equipment and personnel meet exit criteria.

5.1.1 Radiological Surveys

Surveys will be used to monitor and control exposures and the potential spread of contamination. The following subsections describe the surveys to be used and their requirements.

5.1.1.1 Baseline Entry Survey – Equipment

All vehicles and large equipment entering Area 1 will be surveyed by the RCT (Radiation Control Technician) for fixed alpha and beta contamination before its initial entrance into Area 1. The survey will be conducted using a Ludlum Model 12 coupled to a Model 43-5 (or equivalent), and a Ludlum Model 12 coupled to a Model 44-9 (or equivalent) as described in A&A Procedure 2.7 **(Appendix D)**

5.1.1.2 Permitted Area Exit Survey - Personnel

Personnel exiting a Permitted Area will have their shoes and clothing scanned upon leaving the area, as described in A&A Procedure 2.7. Records will include the name of the individual, the results of the exit survey, the location, and the times they entered and left the area on the a standard form such as A&A Form 11, Personnel Monitoring Form or a log sheet attached to a copy of the Radiation Work Permit. A reading of two (2) times the ambient background level will require decontamination before leaving the area.

5.1.1.3 Permitted Area Exit Survey - Equipment

Heavy equipment working inside a Permitted Area will be surveyed by the RCT before leaving the area. All surfaces in contact with soil will be scanned for beta surface activity with a Ludlum Model 12 coupled to a Model 44-9 (or equivalent) as described in A&A Procedure 2.7. A reading of two (2) times the ambient background level will require the equipment be decontaminated and resurveyed before it leaves the Permitted Area.

Sections of the downhole drilling equipment will be sampled with a swipe between sampling locations detect any removable activity on the surface of the tool string. The swipe samples will be screened in the field with a Ludlum Model 12 coupled to a Model 43-5 alpha detector. A final measurement of alpha and beta activity on the smear will be performed using a Ludlum 2929 coupled to a Ludlum 43-10-1 or a low-background alpha/beta counter such as a XLB-5.

5.1.1.4 Final Release Survey - Equipment

Equipment working inside a Permitted Area and equipment that might inadvertently contact contaminated soil outside a cleared easement will be surveyed by the RCT before leaving Area 1. All surfaces in contact with soil will be scanned for alpha and beta contamination with a Ludlum Model 12 coupled to a Model 44-9 (or equivalent), and a Ludlum Model 12 coupled to a Model 44-5 (or equivalent) as described in A&A Procedure 2.7.

Removable contamination will be sampled by swiping 100 cm^2 areas on parts of the equipment that were in contact with soil surfaces as described in Procedure 3.6. These smear samples will be counted with a Ludlum Model 29 coupled to a Ludlum 2929 coupled to a 43-10-1.

If contamination is found, the vehicle will be decontaminated until it meets final release standards listed in Table 2. The equipment identification and the final results will be recorded on the appropriate equipment release form from the A&A Procedures Manual and the equipment will be unconditionally released from Area 1.

Table 2 Final Release Survey Limits for Equipment

Parameter	Limit	Meter Reading [a]
Fixed Alpha (Ra-226 & Th-230)	100 dpm/100cm^2, average 300 dpm/100cm^2, maximum	20 cpm Mo 12/Mo 43-5 60 cpm Mo 12/Mo 43-5
Fixed Beta (U_{nat} & assoc. decay products)	5,000 dpm/100cm^2, average 15,000 dpm/100cm^2, maximum	750 cpm Mo 12/Mo 44-9 2250 cpm Mo 12/Mo 44-9
Removable Alpha	20 dpm/100cm^2, average	Na
Removable Beta	1,000 dpm/100cm^2, average	Na

[a] Nominal values. Meter efficiencies will be reevaluated at the site.

5.1.2 Equipment Decontamination

All equipment (including but not limited to the drill rig) will be surveyed. If radioactive contamination is detected, the equipment will be decontaminated. A phased approach to decontamination will be employed to minimize the generation of solid waste and waste water.

5.1.2.1 Dry Decontamination

It is expected that any contamination will be associated with loose, removable dirt and mud that may attach to the equipment's surfaces during operations. If contamination is detected on equipment after operations are completed in a Permitted Area, an attempt will be made to decontaminate the equipment before moving to the next Permitted Area. Visual patches of dirt and mud will be removed from the contaminated surfaces of the equipment using damp wipes, brushes, and scrapers. Used decontamination supplies will be placed in marked containers or bags. The remainder of material removed during dry decontamination will be placed in a separate container with hard plastic or metal sides and staged for retrieval and sampling. Any solid radioactive waste generated will be packaged and characterized for handling, then disposed at a permitted facility. The equipment will be resurveyed and allowed to leave the next Permitted Area if it meets the requirements described in Section 5.1.1.4.

5.1.2.2 Wet Decontamination of Equipment

If dry decontamination is not sufficient to meet release levels, the equipment will be moved to the radiological decontamination pad. Contaminated surfaces will be scrubbed with brushes and soapy water until they are visually clean. The equipment will be surveyed again for both alpha and beta surface activity. If fixed or removable activity exceeding the release limits is found, the contaminated surface will be decontaminated using more aggressive methods such as pressure washing or abrasive blasting until the release criteria are met.

5.1.2.3 Waste/Water Management

Water used to decontaminate equipment will be placed in marked holding tanks and/or drums, sampled, and packaged and shipped to a licensed, managed disposal site.

Any solid radioactive waste generated will be packaged and characterized for shipping. This material will be shipped to a managed disposal/treatment facilities that are permitted to receive the waste.

5.1.2.4 Final Housekeeping Wash-down

Because of the very high visibility of this sampling event, any equipment released from Area 1 will be washed with soap and water to remove visible dirt from its surfaces prior to its removal from the project. This final housekeeping can be performed in an uncontrolled area and any water generated from this final cleaning of previously released equipment will be considered unimpacted.

5.1.3 Decontamination Pads

Two separate decontamination pads were constructed during Phase 1. A radiological decontamination pad was constructed near PVC-38. This pad is used to decontaminate equipment failing the free-release radiological requirements. A second pad is provided for general cleaning of equipment that has not been exposed to RIM materials. This pad is close to the fence near the entrance road to the OU-1 Area 1.

6 REPORTING

Field investigation activities and the findings from these efforts will be summarized in a stand-alone Subsurface Investigation Summary Report.

The field data (boring logs, soil screening data, survey data, etc.) will be recorded on paper forms and log books. These paper records will be maintained in a managed repository such as an office or a climate controlled storage facility for future reference.

Analytical results will sent in electronic format from the laboratory to Auxier & Associates. Laboratory analytical data will be recorded digitally and maintained in a relational database. Full Level III laboratory reports containing documentation of the analytical process, QA/QC data and analytical instrument performance will be sent in electronic or paper format from the laboratories to Auxier & Associates and EMSI. These analytical reports will include:

- Copies of completed chain of custody forms,
- Instrument calibration and/or instrument quality control records,
- Results for blanks and spikes associated with the reported results,
- Results for duplicates,
- Sufficient documentation to reproduce calculated results from instrument responses, and
- A case narrative describing the analytical process used to produce the published results.

All of the laboratory data will be validated by examining the test results. The validation will allow the data management team to evaluate the level of confidence that a reported result accurately represents the concentration of an analyte in a sample. By validating the reported results, validators can assess a laboratory's performance, identify systematic errors, and judge the lab's degree of compliance with the quality assurance requirements of the project. The laboratory reports and validation packets will be maintained at Auxier & Associates.

Information regarding the progress of the field work and sampling activities will be provided in the monthly progress reports for West lake Landfill Operable Unit 1 (OU-1) prepared by EMSI. Analytical reports will also be provided by EMSI as they are received in conjunction with submittal of the monthly progress reports for OU-1.

FEI will author a final report summarizing:

- Field preparations;
- Boring locations and sample locations;
- Lithology logs;
- Analytical testing and validation results; and
- A discussion on the feasibility of the thermal / isolation barrier alignment.

7 ANTICIPATED PROJECT SCHEDULE

The field investigation activities are anticipated to begin after the GCPT investigation has been concluded and be completed 2 months after initiation. Laboratory reports are expected to be received one month after the completion of the Phase 2 investigation. The investigation summary report is anticipated to be complete and ready for submittal to the EPA one month after the analytical results are received. Please note the schedule will be dependent upon the sonic rig availability.

8 REFERENCES

Auxier 2012 "Survey Procedures Manual, for Radiological Survey Activities." Auxier & Associates, Knoxville TN., 1995. Last revised 2012.

Engineering Management Support, Inc. (EMSI), 2010b Supplemental Feasibility Study West Lake Landfill OU-1, DRAFT, July 23.

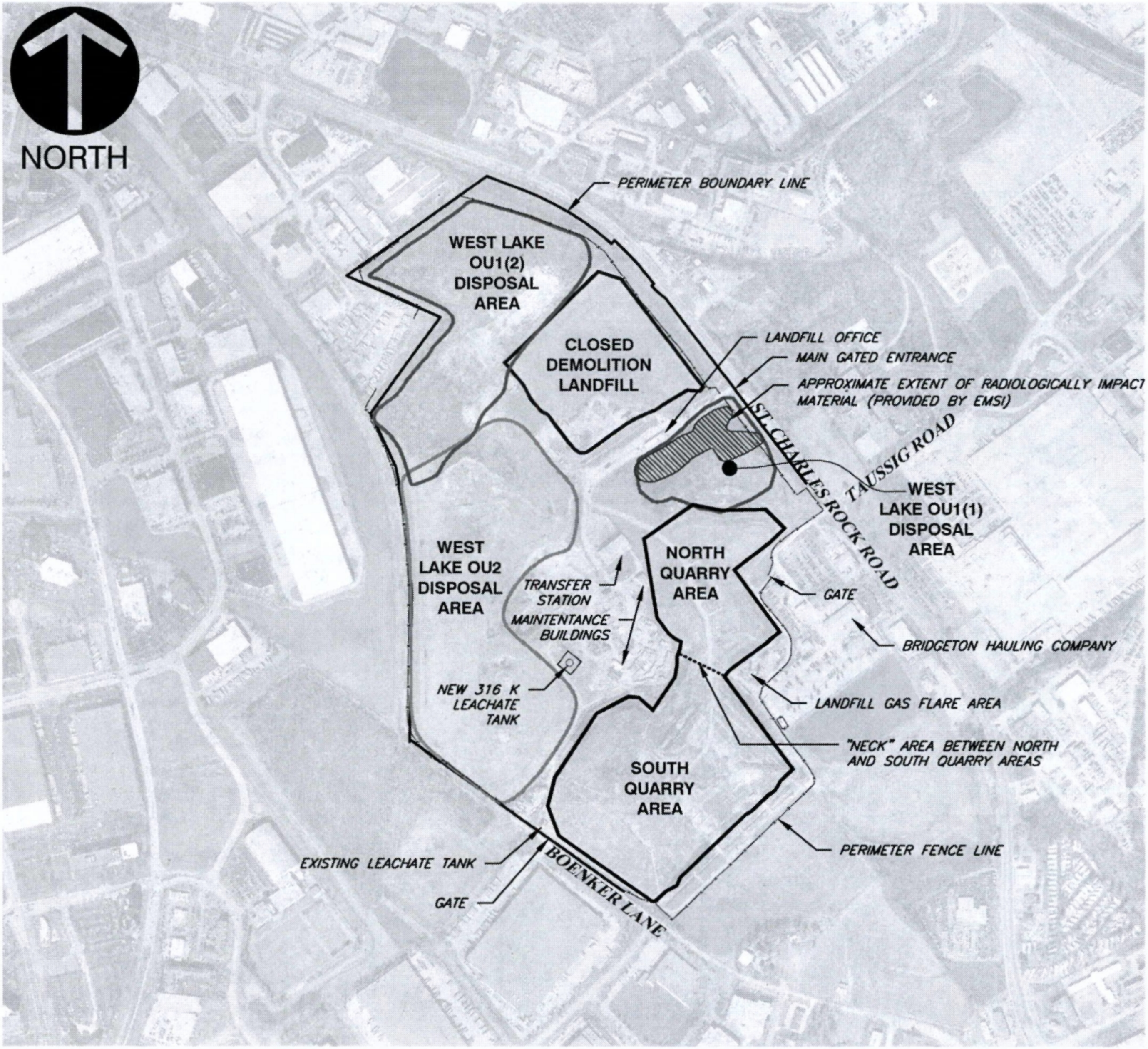
EMSI, 2006, Feasibility Study Report, West Lake Landfill Operable Unit 1, May 8.

EMSI, 2000, Remedial Investigation Report, West Lake Landfill Operable Unit 1, April 10.

Feezor Engineering, Inc., 2013 "Bridgeton Landfill – West Lake Landfill Gamma Cone Penetration Test (GCPT) Work Plan Revision 2" prepared by Feezor Engineering, Inc., P.J. Carey and Associates, Engineering Management Support, Inc., and Auxier and Associates, Inc.

McLaren/Hart, 1996, Soil Boring/Surface Sample Investigation Report, West Lake Landfill Radiological Areas 1 and 2, Bridgeton, Missouri

FIGURES



REFERENCE

1. AERIAL IMAGERY PROVIDED BY EAST WEST GATEWAY COORDINATING COUNCIL OF MISSOURI AND ILLINOIS, COLLECTED IN LATE FEBRUARY AND EARLY MARCH OF 2012.
2. BOUNDARY INFORMATION PROVIDED BY SHERBUT-CARSON & ASSOCIATES, P.C. DRAWING NAME-1111 LEASE EXHIBIT.DWG RECEIVED ON 03/04/2013

SCALE IN FEET

0 1000 2000

BRIDGETON LANDFILL, LLC
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI

FACILITY MAP

DRAWN BY: MSP	CHECKED BY: MRB	APPROVED BY: DRAFT	FIGURE NO.:
DATE: JUN. 2013	DWG SCALE: 1"=1000'	PROJECT NO: 131-178.0001	1

P:\2013\130-484\-CADD\Dwg\SolidWaste\131178-Figure_1.dwg{FACILITY MAP} LS:(6/27/2013 - ccolthorp) - LP: 6/27/2013 11:02 AM


LEGEND
EXISTING GRADE (2' CONTOUR)
EXISTING GRADE (10' CONTOUR)
ELEVATED DOWNHOLE GAMMA READING
BOUNDARY OF ELEVATED DOWNHOLE READINGS
NON-ELEVATED DOWNHOLE GAMMA READING
BOUNDARY OF NON-ELEVATED DOWNHOLE READINGS
INTERPOLATED RIM LIMITS
OVERLAND GAMMA READING, BACKGROUND OR LESS
OVERLAND GAMMA READING, 2X BACKGROUND OR LESS
OVERLAND GAMMA READING, MORE THAN 2X BACKGROUND
FENCE
WEST LAKE LANDFILL
13570 ST. CHARLES ROCK ROAD
BRIDGETON, MISSOURI 63044
WEST LAKE LANDFILL OU-1
AREA 1 RIM INVESTIGATION
PREVIOUS INVESTIGATIONS
FEEZOR ENGINEERING, INC.
FIGURE
2

LEGEND

EXISTING GRADE (2' CONTOUR)
EXISTING GRADE (10' CONTOUR)
POTENTIAL BARRIER ALIGNMENT
GCPT LOCATION
CLEARING PATH
ELEVATED DOWNHOLE GAMMA READING
BOUNDARY OF ELEVATED DOWNHOLE READINGS
NON-ELEVATED DOWNHOLE GAMMA READING
BOUNDARY OF NON-ELEVATED DOWNHOLE READINGS
INTERPOLATED RIM LIMITS
FENCE
ROCK

WEST LAKE LANDFILL
BRIDGETON, MISSOURI

WEST LAKE LANDFILL OU-1
AREA 1 RIM INVESTIGATION

PROPOSED INVESTIGATION

FEEZOR ENGINEERING, INC.

FIGURE 3

APPENDIX A

A&A - Procedure 2.1 (2)

PROCEDURE 2.1
INSTRUMENTATION: CALIBRATION & QUALITY CONTROL

1.0 PURPOSE

1.1 To describe the general approach to calibration and quality control checks of survey instruments.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Calibration

3.1.1 Instruments to be used for quantitative measurements are source calibrated a minimum of every twelve months; more frequent calibration may be necessary for some projects or applications to satisfy requirements of the responsible regulatory agency or following repair of the instrument. Exception: A properly calibrated Pressurized Ionization Chamber may be used as a secondary standard to calibrate response of a gamma detector, relative to true exposure rate (refer to Procedure 2.5).

3.1.2 Calibration is to be performed with standards traceable to the National Institute of Standards and Technology (NIST) or other industry recognized standards organizations.

3.1.3 Records will be maintained for each detector and readout instrument, detailing the calibration and maintenance history. Originals of calibration records are to be maintained at the Knoxville, Tennessee facility; however, copies should accompany instruments to the field measurement location.

Calibration will be performed by the instrument manufacturer or other outside organization. A&A will provide directions/specifications for calibration by outside agencies. An exception to manufacturer calibration is calibration of gamma detectors, using a pressurized ionization chamber (see Procedure 2.5). Calibration for response of surface contamination monitors to radionuclides or radionuclide mixtures for which commercial calibration services are not available or practical may necessitate in-house determination of source response or theoretical calculation of response, based on estimated parameters, e.g., from draft NUREG-1507. If in-house calibration is performed, detailed procedures will be developed, approved by the Field Survey Resources Committee, and placed in the appropriate project file.

3.1.5 Instruments, such as a pressurized ionization chamber, may be calibrated as a detector/readout combination; if calibrated in this manner, quantitative measurements are made only with the components and parameters for which the combination was calibrated.

3.1.6 Detectors and readouts, which are individual pieces of equipment, are usually calibrated separately; however, a calibrated detector may be used with various calibrated readout instruments, even if a specific source calibration of the combination has not been performed. To enable such use, the baseline response of the calibrated detector to a designated check source is determined immediately after return of the detector from calibration, using a readout instrument (for which the calibration is also current) with the operating parameters, e.g., high voltage and threshold (input discriminator), set according to those parameters at which the detector was calibrated.

Where possible, for an analog readout instrument, select a scale on which the source will provide a reading of between half- and full-scale; for an integrating digital readout instrument select a count time which will result in accumulation of at least 10,000 counts. Determine and record on the appropriate form, the gross and net instrument response on the Baseline Response record form. For instruments that will be operated in the scaler mode, repeat the determination ten times and calculate the average; one reading is recorded for instruments to be operated in the ratemeter mode. A range of ± 20 % of that response to the designated source is established as the criterion for evaluating acceptance of other readouts (with properly set operating parameters) with that detector. Each detector/readout combination, which satisfies the acceptance criterion for the designated baseline check source may be assumed to be responding with the efficiency established for the detector. This record is filed with other detector response, calibration, and maintenance information.

3.2 Quality Control Check

3.2.1 Equipment

3.2.1.1 Instrument (detector and/or readout)

3.2.1.2 Cables

3.2.1.3 Check source

3.2.1.4 Pulse generator (Ludlum Measurements, Inc. Model 500)

3.2.1.5 Calibration documents

3.2.1.6 Forms for Baseline Detector Response and Instrument QC Check

3.2.2 Procedure

3.2.2.1 This procedure is applicable to all field survey instruments.

3.2.2.2 Quality control checks are performed prior to sending instruments to the field, at the beginning and end of each day of data acquisition, upon return of the instrument from a field assignment, at any time instrument factors (batteries, cables, operating parameters, etc.) which could effect the instrument response are altered, and whenever the performance of an instrument is in question.

3.2.2.3 Assure that the baseline response has been established, that the response to the check source has been determined, and that the response was satisfactory (refer to Step 3.1.6).

3.2.2.4 All equipment associated with instrument operation (e.g., tubing, flow meters, collimators, headphones, etc.) should be in place when testing response to assure proper operation of the complete system.

3.2.2.5 Turn the instrument on and check batteries. Record result on Instrument QC check form; replace batteries and repeat test, if necessary.

3.2.2.6 Check high voltage, threshold, and other operating parameters; record values and, if necessary, adjust parameters to predetermined values and repeat checks. For some instruments it will be necessary to use the Ludlum Pulse Generator to determine and adjust the operating parameters.

3.2.2.7 Determine and record the background response. The site-specific background will be determined at each site at a location selected by the Site Survey Manager to have low and consistent background levels. Typical background instrument responses are as follows:

Instrument	Background Response
Ludlum Model 19	5 to 15 μR/h
Bicron microrem	3 to 10 μrem/h
Ludlum 44-2	1,000 to 4,000 counts/min
Ludlum 44-9	to 60 counts/min

3.2.2.8 Place the baseline check source in contact with the detector and determine and record the analog or integrated digital response, as appropriate. Calculate the net response and compare with the previously established acceptable baseline response range. If the source falls within that range, the instrument may be considered to be operating properly. If the response does not fall within the acceptable range, the instrument should not be used for quantitative measurements unless a thorough evaluation justifies otherwise.

3.2.2.9 If the instrument response to the baseline source is acceptable, select a QC check source and place the appropriate surface in contact with the designated location on the detector or instrument. Turn on the audible output to confirm its operation.

3.2.2.10 Where possible, for an analog readout instrument, select a scale on which the QC check source will provide a reading of between half- and full-scale; for an integrating digital readout instrument select a count time which will result in accumulation of at least 10,000 counts. Determine and record the gross and net instrument response on the appropriate form. For instruments that will be operated in the scaler mode, repeat the determination ten times and calculate the average; one reading is recorded for instrument to be operated in the ratemeter mode. Calculate and enter the range of acceptable instrument response as the average ± 20%.

3.2.2.11 To check response of the instrument, relative to the predetermined acceptable QC response range, place the source at the designated source test position and determine and record the analog or integrated digital response, as appropriate. Calculate the net response and compare with the previously established acceptable response range. If the source falls with that range, the instrument may be considered to be operating properly. If the response does not fall within the acceptable range, data recorded since the previous acceptable test should be considered questionable, and not used for quantitative purposes, unless a thorough evaluation justifies otherwise

APPENDIX B

A&A – Downhole Logging

PROCEDURE 3.3
SOIL SAMPLING

1.0 PURPOSE

To describe the procedures for collecting soil samples.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 EQUIPMENT

3.1 Digging implement: garden trowel, shovel, spoons, post-hole digger, etc

3.2 Special sampling apparatus (cup cutter, shelby tube, metal or plastic tube, etc.) as required

3.3 Drilling equipment: drilling rig, portable motorized auger, manual auger

3.4 Subsurface sampling apparatus: split-spoon sampler, shelby tube sampler

3.5 Sample containers

3.6 Tape

3.7 Indelible pen

3.8 Labels and security seals

3.9 Equipment cleaning supplies, as appropriate

3.10 Record forms and/or logbook

4.0 PROCEDURE

4.1 NOTE: Typically, soil contamination criteria for radionuclides are applicable to the average concentration in 15 cm layers of soil, therefore, the sampling protocols described here are based on sampling 15 cm increments. The method used to sample soil will depend on the specific application and objective. Therefore, several techniques are described in this procedure and selection will be on a site-specific basis. Special situations (e.g., evaluating trends or airborne deposition, determining near-surface contamination profiles, and measuring non-radiological contaminants, necessitate special sampling procedures. These special situations are evaluated and incorporated into site specific survey plans as the need arises.

Direct surface and 1 meter gamma radiation measurements may be performed at each location before initiating sampling. This will identify the presence of gross radionuclide contamination that will require special handling and equipment cleanup procedures. If contamination is suspected, a beta-gamma "open" and "closed" measurement may also be desired before sampling begins.

4.2 Surface Soil

4.2.1 Loosen the soil at the selected sampling location to a depth of 15 cm, using a trowel or other digging implement.

4.2.2 Remove large rocks, vegetation, and foreign objects (these items may also be collected as separate samples, if appropriate).

4.2.3 Place approximately 1 kg of this soil into the sample container. If it is not possible to reach a depth of 15 cm using a hand tool (i.e. trowel or shovel) 1 kilogram of soil should be collected from the accessible depth. The actual depth should be recorded on the sample container and the appropriate record form.

4.2.4 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie the sample bag strings).

4.2.5 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.2.6 Record sample identification, location, and other pertinent data on appropriate record forms, maps, drawings, and/or site logbook.

4.2.7 If the location has been identified as having elevated activity, a measurement should be obtained after the sample is collected to determine the possibility of contamination at a depth greater than 15 centimeters. If a subsurface sample is deemed necessary, refer to the appropriate section below.

4.2.8 Clean sampling tools, as necessary, according to the procedure in the Quality Assurance Plan, before proceeding with further sampling.

4.3 Subsurface Soil (Option 1)

4.3.1 Procedure applicable to depths of approximately 3 m when boreholes or trenches have been dug and remain uncollapsed or do not contain water.

4.3.2 When direct radiation measurements are required (surface and borehole logging) they are to be performed prior to sample collection in order to identify the presence of gross radionuclide contamination requiring special handling or cleanup (see the Quality Assurance Plan and/or Health and Safety Plan). If borehole logging is to be done it should be completed before sampling begins (see Procedure 2.6).

4.3.3 Place a plastic bag liner into the downhole sampler and secure with a large rubber band.

4.3.4 Lower the sampling tool to the desired depth in the borehole or trench.

4.3.5 Scrape the inside borehole or trench wall with the toothed edge of the tool until approximately 1 kg of sample is collected.

4.3.6 Transfer the plastic bag and sample into the container.

4.3.7 Seal the bag using a twist-tie, cap, and tape the cap in place (or tie sample bag ties).

4.3.8 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.3.9 Record sample identification, location, depth, and other pertinent data on the appropriate record forms, map, drawing, and/or site logbook.

4.3.10 Clean sampling tools, as necessary, in accordance with instructions in the Quality Assurance Plan, before proceeding with further sample collection.

4.4 Fixed Geometry and Subsurface Soil (Option 2)

4.4.1 This procedure is appropriate for sampling at depths exceeding 3 m, in boreholes where walls do not remain intact or that fill with water and in situations where it is necessary to retain the orientation of the sample. An example where the latter may be the case, would be when it was necessary to analyze segmented aliquots to determine radionuclide concentrations as a function of depth. This approach could incorporate surface sampling as well as subsurface sampling.

4.4.2 If necessary, drill the borehole to the desired sampling depth using an auger.

4.4.3 Drive a split-spoon, shelby tube, or similar design sample collector through the specified sampling depth.

4.4.4 Withdraw the collecting device; the collected core may be removed at this time.

4.4.5 If the collected core is removed, place the entire core, or a portion of the core, into a sample container. The core may be split into multiple segments, representing different sampling depths. If the core is to remain in the sampling device, the ends are sealed and the orientation noted.

4.4.6 Label and secure the sample container in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

4.4.7 Record sample identification, location, depth, and other pertinent data on the appropriate record forms, map, drawing, and/or site logbook.

4.4.8 Monitor the sample hole to determine activity level. If the activity level is elevated, it may be desirable to repeat items 4.4.1- 4.4.6. If the activity level has dropped to background, record the measurement and monitor the area, including personnel and equipment, to determine the extent of decontamination that may be necessary.

4.4.9 Clean sampling tools, as necessary, in accordance with instructions in the Quality Assurance Plan, before proceeding with further sample collection.

APPENDIX C

A&A – Chain of Custody

PROCEDURE 3.8
SAMPLE CHAIN-OF-CUSTODY

1.0 PURPOSE

To provide a method for sample chain-of-custody.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

Chain-of-custody is initiated upon collection (or receipt) of samples and continues until samples are transferred to another organization or are disposed. An acceptable chain-of-custody is maintained when the sample is under direct surveillance by the assigned individual; the sample is maintained in a tamper-free container; or the sample is within a controlled-access facility. The chain-of-custody is recorded on a standardized A&A form (see Appendix A) or a form provided by another organization, such as an analytical laboratory or another sampling agency.

3.1 Field Procedures

3.1.1 An individual present during sample collection is designated as the sample custodian and is responsible for maintaining surveillance of the sample until the custody of that sample is transferred to another party. Samples must, at all times, be in the possession and under the direct surveillance of the sample custodian, or secured in a locked vehicle, building, or container. The sample custodian initiates a chain-of-custody form, daily, for all samples collected or received on that day.

3.1.2 Samples may be listed on the form as an individual entry or group of samples having common characteristics and originating from the same site may be recorded as a single entry, provided information describing each sample in the group (e.g. a completed field data form) is attached to or referenced on the custody form.

3.1.3 If sample custody is to be transferred (relinquished), the container and its contents are inspected by the individual accepting custody to assure that tampering has not occurred and custody has therefore been maintained. If evidence of tampering is observed or if any deviations or problems are noted, a notation must be provided on the form by the individual accepting custody. The sample collector must sign the first "Relinquished by" block and the receiver must complete the first "Received by" block.

3.1.4 If sample custody will not be assured under one of the conditions in item 3.0 above, a security seal is placed on the container of the samples. A security seal is a wire, tape, or other such item, which is uniquely identified (numbered), and can be affixed to a package in a manner as to require damaging the seal if the package is opened. Damage to the seal thereby alerts the recipient of a package to the possibility of tampering with the contents. The number of the seal is entered onto the Chain-of-Custody form. Samples, which are under security seals, do not have to be maintained in a secure area; however, precautions should be taken to restrict sample access to authorized individuals.

3.1.5 The original of the chain-of-custody form must contain all signatures and other pertinent records regarding custody. Therefore the original is retained in the possession of the individual who has custody.

3.1.6 As long as samples remain in custody of the sampler, both copies of the chain-of-custody form are to accompany the samples. If custody is transferred to another individual and the control requirements in item 3.0 above are not satisfied, the duplicate copy of the form is packaged with the samples and the original remains with the individual having custody.

3.1.7 Samples collected by other organizations and provided to A&A personnel will have chain-of-custody initiated for them by the individual receiving the samples. When the organization has an established chain-of-custody in place, a copy of the form will be attached to the A&A form.

3.2 Sample Transport

3.2.1 Samples must comply with regulations of the Department of Transportation, if they are to be transported over or through publicly accessible transport routes. The Health and Safety Plan describes the procedure for assuring compliance with this requirement.

3.2.2 Unsealed samples may be transported by a vehicle controlled by the person having custody of the samples, or in that person's hand carried baggage.

3.2.3 Transport by mail, checked baggage, common carrier, or other mode not controlled by the sample custodian of record, requires that security seals be used.

3.2.3 The method of transport is to be identified on the original chain-of-custody record. If inner containers are sealed, additional seals on outer packaging are not required.

3.3 Samples sent to other organizations

3.3.1 The custodian will sign the "Relinquished by" space and the original form will be packed with the samples.

3.3.2 Receiving organizations will be requested to check the container and its contents for signs of tampering and note any deficiencies in the "Comments" portion of the form.

3.3.3 When samples will not be returned to A&A, the receiving organization will be asked to return the original of the form. The form will be provided to the Project Manager, for inclusion with the project records.

3.3.4 If samples will be returned to A& A, the receiving organization will be asked to sign the "Relinquished by" space and pack the form with the samples for return shipment. Upon receipt, the samples and form will be provided to the Project Manager, who will sign the "Received" space and place a copy in the project file.

3.2.3 Instrument cables

3.2.4 Check sources

3.2.5 Record Forms and/or field logbook

3.3 Quality Control Check

Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and source responses following Procedure 2.1.

3.4 Surface Scanning

3.4.1 Headphones or other audible signal operating modes are used for scanning.

3.4.2 Set the instrument response for "FAST", response where possible.

3.4.3 Pass the detector slowly over the surface. The detector should be kept as close to the surface as conditions allow. The speed of detector movement will vary depending upon the radionuclide of concern and the experience of the surveyor. While scanning for alpha or beta activity, the detector is typically moved about one detector width per second.

3.4.3 Note increases in count rate as indicated by the audible meter output. Identifiable increases in the audible response suggest possible contamination and should be resurveyed at a slower rate to confirm findings.

3.5 Personnel Monitoring

3.5.1 When monitoring for skin or clothing contamination, give particular attention to the hands, shoes, pant and shirt cuffs, knees, and other surfaces which have a high likelihood of contamination.

3.5.2 If there is detectable contamination, it should be removed as directed by the Health and Safety Committee (HSC) Chairperson. Decontamination guidance will be provided in the Survey Work Plan. The Site Safety Officer will implement decontamination or other contamination control actions at the project site.

3.6 Equipment Monitoring

3.6.1 For equipment surveys, attention should be given to monitoring cracks, openings, joints, and other areas where contamination might accumulate.

3.6.2 Measure levels of total and removable surface contamination (see Procedures 2.3 and 3.6) at locations of elevated direct radiation identified by the scan and at additional representative surface locations.

3.6.3 Acceptable surface contamination levels will be established on a project-specific basis, with details, including decontamination instructions, provided in the Survey Work Plan.

3.7 Document results of contamination surveys in field records

PROCEDURE 2.3
DIRECT RADIATION MEASUREMENT

1.0 PURPOSE

1.1 To describe the method for measuring total alpha and beta radiation levels on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring that this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment

3.1.1 Ratemeter-scaler: Model 3, Model 2220 or 2221, Ludlum Instrument Corporation; or equivalent

3.1.2 Detector: Selected detectors are listed below: Equivalent detectors are also acceptable

Activity	Detector Type	Model
alpha	ZnS scintillator	Ludlum 43-1 or 43-5, Eberline AC3-7 or AC3-8
	gas proportional	Ludlum 43-68
beta	Geiger-Mueller	Ludlum 44-9, Eberline HP-260
	gas proportional	Ludlum 43-68

3.1.3 Cables

3.1.4 Check source

3.1.5 Record forms

3.2 Quality Control Check

3.2.1 Assemble instrument, turn on, check battery, and adjust high voltage and threshold, if necessary. Check background and check source responses. Follow the procedures described in Procedure 2.1.

3.3 Direct Measurement

3.3.1 When applicable, team members performing instrument checks will calculate the average and maximum "field action levels" for instrument combination based on the specific site criteria and background.

Action level (cpm) = [site criteria (dpm/100 cm^2) x E x G x T] + B

T = count time (minutes)
E = operating efficiency (counts/disintegration)
G = geometry (total detector area (cm^2)/100)

	Total Area	Active Area
43-5 detector area =	80 cm^2	60 cm^2
43-1 detector area =	80 cm^2	50 cm^2
43-68 detector area =	126 cm^2	100 cm^2
44-9 detector area =	20 cm^2	15.5 cm^2
HP-260 detector area =	20 cm^2	15.5 cm^2

B = background (cpm)

A field count at or above this value indicates that further investigation in this location is necessary.

NOTE: For a particular site, the action level may be established as any activity exceeding background.

3.3.2 Select an appropriate counting time. A counting time is desired which will achieve a minimum detectable activity (see Procedure 4.2) value less than 50% of the applicable criteria. For most radionuclides a 1-minute count, using the instruments listed above, is adequate to achieve this sensitivity. For radionuclides having guidelines of 5000 dpm/100 cm^2, average and 15,000 dpm/100 cm^2, maximum, 0.5 minute counting times may be acceptable.

3.3.3 Place the detector face in contact with the surface to be surveyed. The detector face is typically constructed of a very thin and fragile material, so care must be exercised to avoid damage by rough surfaces or sharp objects. (Scans should have been performed, prior to this point, to identify representative locations and locations of elevated direct surface radiation for measurement.)

3.3.4 Set the meter timer switch, press the count-reset button, and accumulate the count events until the meter display indicates that the count cycle is complete.

3.3.5 Record the count and time on the appropriate record form.

3.3.6 If the location has a surface activity level above background, the area around the measurement locations should be scanned to determine the homogeneity of the measured activity level in the area. Dimensions and activity levels of inhomogeneities should be documented on the appropriate record form.

3.3.7 The surface activity may be calculated according to Procedure 4.3.

PROCEDURE 3.6
REMOVABLE ACTIVITY SAMPLING

1.0 PURPOSE

1.1 To provide guidelines for measuring removable alpha and beta radioactivity on equipment and building surfaces.

2.0 RESPONSIBILITIES

2.1 The Site Survey Manager is responsible for assuring this procedure is implemented.

2.2 Survey team members are responsible for following this procedure.

3.0 PROCEDURE

3.1 Equipment and Materials

3.1.1 Smears, Mazlin wipes, filter papers (like Whatman 47 mm dia. glass fiber) or equivalent

3.1.2 Glassine or paper envelopes

3.1.3 Record forms

3.1.4 Counting equipment

3.2 Sample Collection

NOTE: Direct measurements will be completed before a smear sample is taken.

3.2.1 Grasp the smear (filter) paper by the edge, between the thumb and index finger.

3.2.2 Applying moderate pressure with two or three fingers, wipe the numbered side of the paper over approximately 100 cm^2 of the surface.

3.2.3 Place the filter in an envelope.

3.2.4. Record the smear number, site, date, location of the smear, and name of sample collector on the envelope.

3.2.5 Label and secure in accordance with Procedures 3.7 and 3.8. Record pertinent information on the Chain-of-Custody Form.

3.2.6 If the direct measurement was elevated, the smear should be monitored (procedures 2.2 and 2.3) to determine whether contaminated material was transferred to the smear. If an activity level greater than 250 cpm is detected, the smear envelope should be marked as such.

NOTE: Smears having activity levels greater than 2500 cpm should be counted using field instrumentation. Decisions regarding further analyses and method of disposal of contaminated smears will be made by the PM and SSM on a case-by-case basis.

3.3 Field Sample Measurement

3.3.1 If the object of the survey is to determine if radon or thoron daughter products or other short half-life radionuclides are present, the smears should be counted within 1-2 hours before significant decay of short-lived radionuclides has occurred.

3.3.2 If necessary, smears can be counted in the field using portable instrumentation (see Procedure 2.3).

3.3.3 Record count and counting time data on the appropriate record form.

3.3.4 Subtract the background count (determined by counting blank or unused smear) and convert net count to dpm/100 cm^2, using proper time and detector efficiency values.

$$\frac{DPM}{100CM^2} = \left(\frac{NETCOUNT}{TIME(\mathrm{MIN}) * EFFICIENCY * \left(\frac{COUNT}{DISINTEGRATION} \right) * OTHERMODIFIYINGFACTORS} \right)$$